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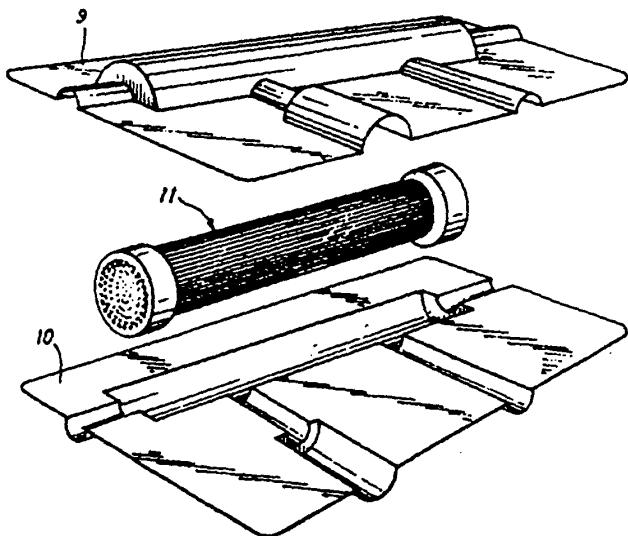


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(54) Title: MEMBRANE FILTER UNIT AND PROCESS OF PRODUCING SAID UNIT



(57) Abstract

There is described a membrane unit wherein at least two outer casing portions are sealed together around a membrane. The unit is desirably formed from a process whereby the two outer casing portions are provided, a membrane is located within the casing and said casing portions are sealed together, advantageously with blue light or UV light curing adhesive. The membrane may be in the form of hollow fibre(s) and a preliminary step involving the formation of a plug of adhesive around the fibre may be present in the process. The set plug of adhesive may be trimmed and then placed into the outer casing portions for sealing therein.

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1 "Membrane Filter Unit and Process of Producing said
2 Unit"

3

4 The present invention is concerned with a process for
5 producing sealed units which comprise a membrane
6 barrier and the units produced by that process.

7

8 Sealed membrane units are desirable for many purposes
9 which require a filtration step. Generally, the
10 membrane is sealed into the unit in such a way that the
11 mother liquor (liquid to be processed) is separated
12 from the filtrate by the membrane. Where the membrane
13 unit is to be used for medical purposes for example
14 dialysis, it is of course particularly important for
15 the unit to be sealed completely and for the membrane
16 to be clean, preferably sterile.

17

18 Currently sealed membrane units of this type are formed
19 using a one-part (generally tubular) outer casing. The
20 membrane fibres are threaded through the outer casing
21 and the ends of the membrane are then fixed in place by
22 adhesive. The adhesive is introduced into the outer
23 casing and the whole unit is spun, so that the
24 centrifugal forces created cause adhesive to locate at
25 each end of the outer casing. The adhesive is then

1 allowed to set. However, this procedure is time
2 consuming and the need to spin the units requires
3 expensive machinery to ensure adequate results.
4 Moreover, it cannot be guaranteed that an adequate seal
5 will be produced at each end of the unit so that
6 careful testing of each unit is required. In addition,
7 the ends of the hollow fibre membranes frequently
8 become blocked by adhesive during the spinning process.
9

10 The present invention lies in the recognition that a
11 suitable unit may be formed using a much simpler
12 methodology.

13

14 Thus, the present invention provides a process for
15 forming a membrane unit wherein the outer casing is
16 formed in two casing portions, a membrane is located
17 within the casing and said casing portions are sealed
18 together.

19

20 The present invention also provides a membrane unit
21 wherein at least two outer casing portions are sealed
22 together around a membrane. Generally the membrane
23 unit will be produced by the process described above.

24

25 The membrane will normally be positioned or shaped to
26 divide the internal volume of the outer casing into two
27 discrete areas.

28

29 The seal between the membrane and the outer casing
30 portions should be sufficiently tight so that
31 communication between the two volumes described by the
32 membrane only takes place by movement of material
33 across the membrane itself. The seal between the outer
34 casing portions should be sufficiently tight to prevent
35 escape of the mother liquor or filtrate at the pressure
36 at which the filtration is conducted.

1 In one embodiment a bundle of membrane fibres are cut
2 roughly to length and are placed into a prepared mould.
3 On closure of the mould the ends of the membrane bundle
4 are held firmly. A quick-setting adhesive is injected
5 into the mould close to each end of the membrane fibre
6 bundle. The mould is formed so that the injected
7 adhesive forms a plug of pre-determined size and/or
8 shape close to each end of the membrane bundle. The
9 adhesive is allowed to set. Preferably the adhesive is
10 cured by exposure to UV light. Once the adhesive plugs
11 have set, the membrane bundle is released from the
12 mould. The exterior end of each plug is preferably
13 trimmed, for example by use of a sharp knife or
14 guillotine, which also slices through the membrane
15 fibres ensuring that the exposed ends of each membrane
16 fibres are free of cured adhesive. The membrane bundle
17 is then placed into a pre-prepared outer casing
18 portion. This casing portion, usually prepared by
19 thermoforming or casting is adapted so that a tight fit
20 with the adhesive plugs are formed when the casing has
21 been completed. The casing portions are adfixed
22 together, optionally with adhesive, to form a sealed
23 unit. Instead of using adhesive to complete the outer
24 casing, the casing portions may be adapted to join
25 together by a "snap fit" arrangement.

26

27 The above methodology of producing a plug around the
28 membrane at a point where the membrane is to be held in
29 the outer casing may also be used for a single hollow
30 fibre membrane or for a sheet membrane. For sheet
31 membranes the step of trimming the membrane and plug
32 ends may be omitted since such membranes have no lumen
33 to be blocked by adhesive.

34

35 In another embodiment the membrane is shaped as a flat
36 sheet, rather than as a hollow fibre. In this

1 embodiment the flat sheet membrane(s) may be adhered
2 directly to the outer casing portions, thus dividing
3 the chamber bounded by the outer casing into two
4 discrete volumes.

5

6 The adhesive used in the process of the present
7 invention may be any adhesive material which does not
8 react with the membrane or outer casing materials in a
9 deleterious manner. Preferably the adhesive material
10 is quick setting, ie cures within minutes, for example
11 under 5 minutes. For certain embodiments adhesive
12 material which cures upon exposure to light is
13 particularly desirable. For example in medical
14 applications it may be preferred to use adhesive which
15 cures upon exposure to light, especially blue light or
16 UV light.

17

18 Specific mention may be made of light or UV curable
19 polymers available from Ablestick Ltd (for example LCM
20 32, LCM 34 and LCM 35), Bostick Ltd or Dynax Inc
21 (especially 191M) as being useful in this regard.

22

23 The membrane for use in the device of the invention may
24 be of any convenient shape and mention may be made of
25 hollow membrane fibres and flat sheet or tubular
26 membranes. Hollow membrane fibres or bundles of such
27 fibres may be preferred in certain situations since
28 this form permits a relatively large surface area
29 through which filtration may occur. For other
30 applications, however, flat membrane sheets (or bundles
31 of such sheets) may be preferable. The membranes may
32 contain pores of sizes from 0.001 to 30 microns in
33 diameter or alternatively may possess Molecular Weight
34 cut-off values from, for example 100 to 1,000,000 (eg.
35 300 to 100,000, 500 to 1,000) Daltons.

36

1 The membrane may be made of any convenient material and
2 the present invention is not limited to the membrane to
3 be used. Generally the membrane will be selected for
4 the filtration size. Ceramic filters, for example, may
5 filter particles of diameter 5.0 μm to 0.1 μm and
6 hollow fibre membranes may filter molecules of 1 mDa to
7 5 kDa. Suitable membranes are available commercially
8 and may be made of polysulphone, cellulose, cellulose
9 diacetate, polypropylene, ceramics materials and/or
10 other co-polymers.

11

12 Where the membrane is a ceramics material it is
13 possible for the tight seal between the membrane and
14 the outer casing to be formed by use of an "O" ring or
15 the like formed of suitably resilient material, such as
16 rubber or plastics.

17

18 As stated above the outer casing may be formed of any
19 materials which may be shaped as desired. Generally
20 therefore a castable or thermoformable material will be
21 used. As examples, polycarbonate, polypropylene, PVC,
22 high impact styrene, HDPE and acrylic materials may be
23 mentioned.

24

25 Usually the outer casing portions will be shaped to
26 allow a suitable amount of adhesive to be placed
27 thereon. Thus, edges will normally have a lip where
28 joining to another edge is required.

29

30 Optionally the outer casing portions are shaped to
31 permit connections with inlet and outlet ports.
32 Optionally additional inlet/outlet ports (for example
33 two, three or four additional ports) are present to
34 enable monitoring of the filtration process or for
35 inserting a second fluid to control the pressure across
36 the membrane.

1 Optionally connection tubes are located with the outer
2 casing portions along with the membrane and a single
3 adhesion step is used to seal the membrane and outer
4 casing and also the inlet/outlet connection tubes.
5 Likewise sensors can be located in position prior to
6 sealing of the outer casing.

7

8 By way of example embodiments of the invention are
9 shown in Figures 1-3.

10

11 Figure 1 shows general detail of the construction of
12 the filter unit. Moulded casing halves 9 and 10 are
13 sealed together with a UV-activated acrylic sealant to
14 enclose a hollow fibre bundle membrane unit 11. The
15 membrane unit 11 is bonded to the outer casing in such
16 a way that a seal is formed at the ends of the whole
17 filter cell.

18

19 Figure 2 shows a unit according to the present
20 invention with outer casing portions 1, 2 and 2'.
21 Upper outer casing portions 2 and 2' are alternatives
22 allowing flexible manufacturing capacity. A membrane
23 bundle 3 is illustrated with cured adhesive plugs 4, 5
24 at each end thereof. The plugs 4, 5 have been trimmed
25 at their outer edges so that the end of each hollow
26 membrane fibre is fully exposed. The adhesive plugs 4,
27 5 fit snugly into corresponding indentations 6 in the
28 outer casing portions 1, 2, 2'. To seal the unit
29 adhesive is smeared onto lip 7 of either or both upper
30 and lower outer casing portions. Optionally
31 indentations 6 may also receive adhesive. The membrane
32 bundle 3 is located in the outer casing portions so
33 that the plugs 4, 5 are both correctly located in
34 indentations 6. The outer casing portions 1 and 2 (or
35 1 and 2' as appropriate) are then aligned and held
36 together whilst the adhesive sets firmly. The unit is

1 shaped so that a tight seal around each plug 4, 5 is
2 produced.

3

4 Inlet and outlet ports 8, 9 are also illustrated and
5 optionally connectors may be adfixed thereto. Likewise
6 side ports 10 are also shown; these enable sampling of
7 the mother liquor during the process or addition of a
8 second fluid to the mother liquor, for example to
9 control the trans-membrane pressure. Alternatively the
10 side ports may be used to hold a sensor which monitors
11 the filtration process.

12

13 Figure 3 illustrates an alternative unit according to
14 the present invention. This unit is formed as
15 described for the unit of Figure 2 but the membrane
16 bundle is bent into a "U"-shape to fit into the outer
17 casing portions.

18

1 Claims

- 2 1. A membrane unit wherein at least two outer casing
3 portions are sealed together around a membrane.
- 5 2. A membrane unit as claimed in Claim 1 wherein the
6 membrane is a hollow fibre(s) membrane.
- 8 3. A membrane unit as claimed in Claim 1 wherein the
9 membrane is a flat sheet membrane.
- 11 4. A membrane unit as claimed in any one of Claims 1
12 to 3 having at least one additional inlet/outlet
13 port.
- 15 5. A process for forming a membrane unit wherein the
16 outer casing is formed in two casing portions, a
17 membrane is located within the casing and said
18 casing portions are sealed together.
- 20 6. A process as claimed in Claim 5 wherein an
21 adhesive plug is formed around the membrane.
- 23 7. A process as claimed in Claim 6 wherein the
24 adhesive plug is formed from light curing
25 adhesive.
- 27 8. A process as claimed in either one of Claims 6 and
28 7 wherein the ends of the set adhesive plugs are
29 trimmed before insertion into the outer casing
30 portions.
- 32 9. A process as claimed in any one of Claims 5 to 8
33 wherein the membrane comprises a hollow fibre
34 membrane.

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9

- 1 10. A process as claimed in any one of Claims 5 to 9
2 wherein the casing portions are sealed together
3 and to the membrane using light curing adhesive.

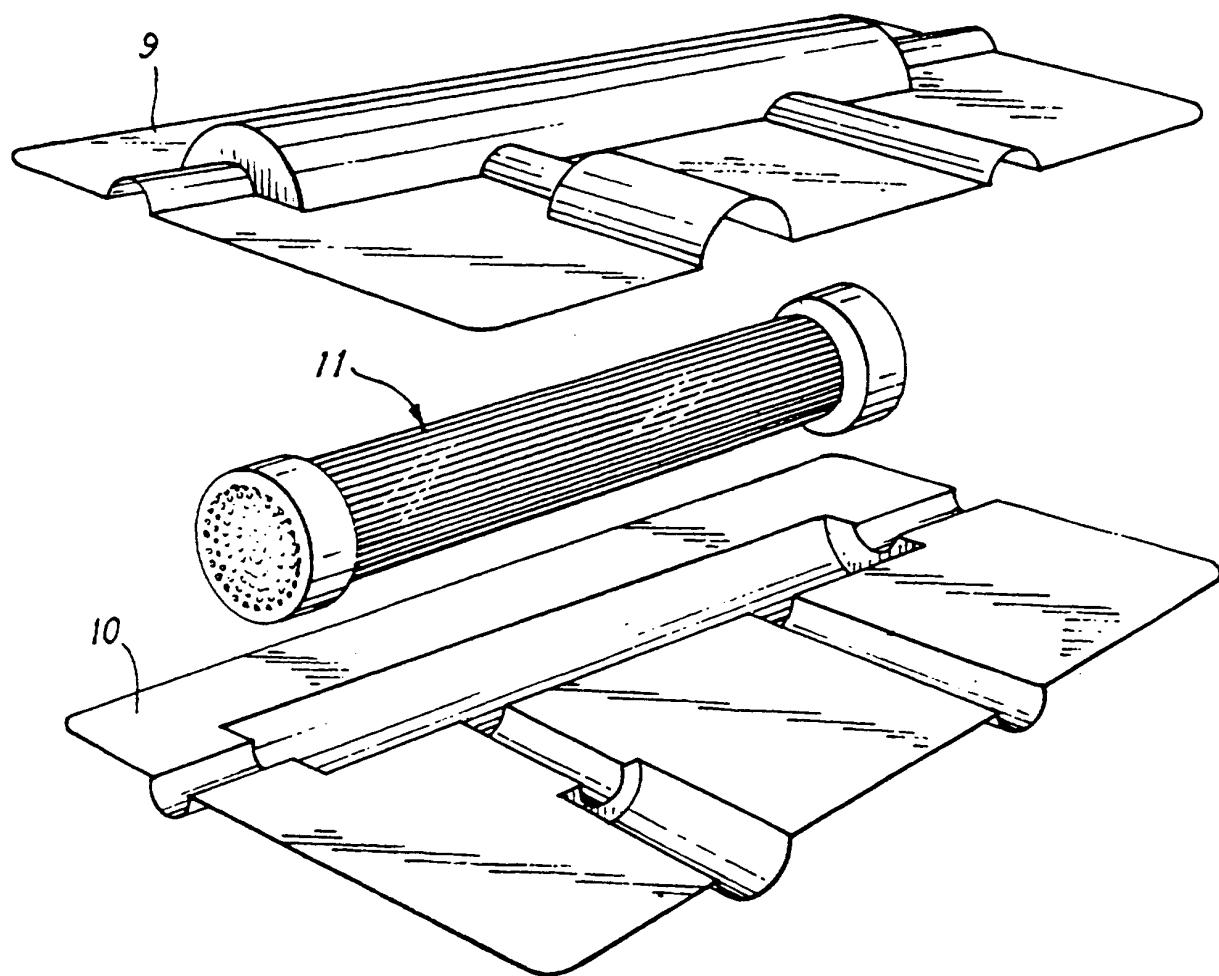


FIG. 1

SUBSTITUTE SHEET (RULE 26)

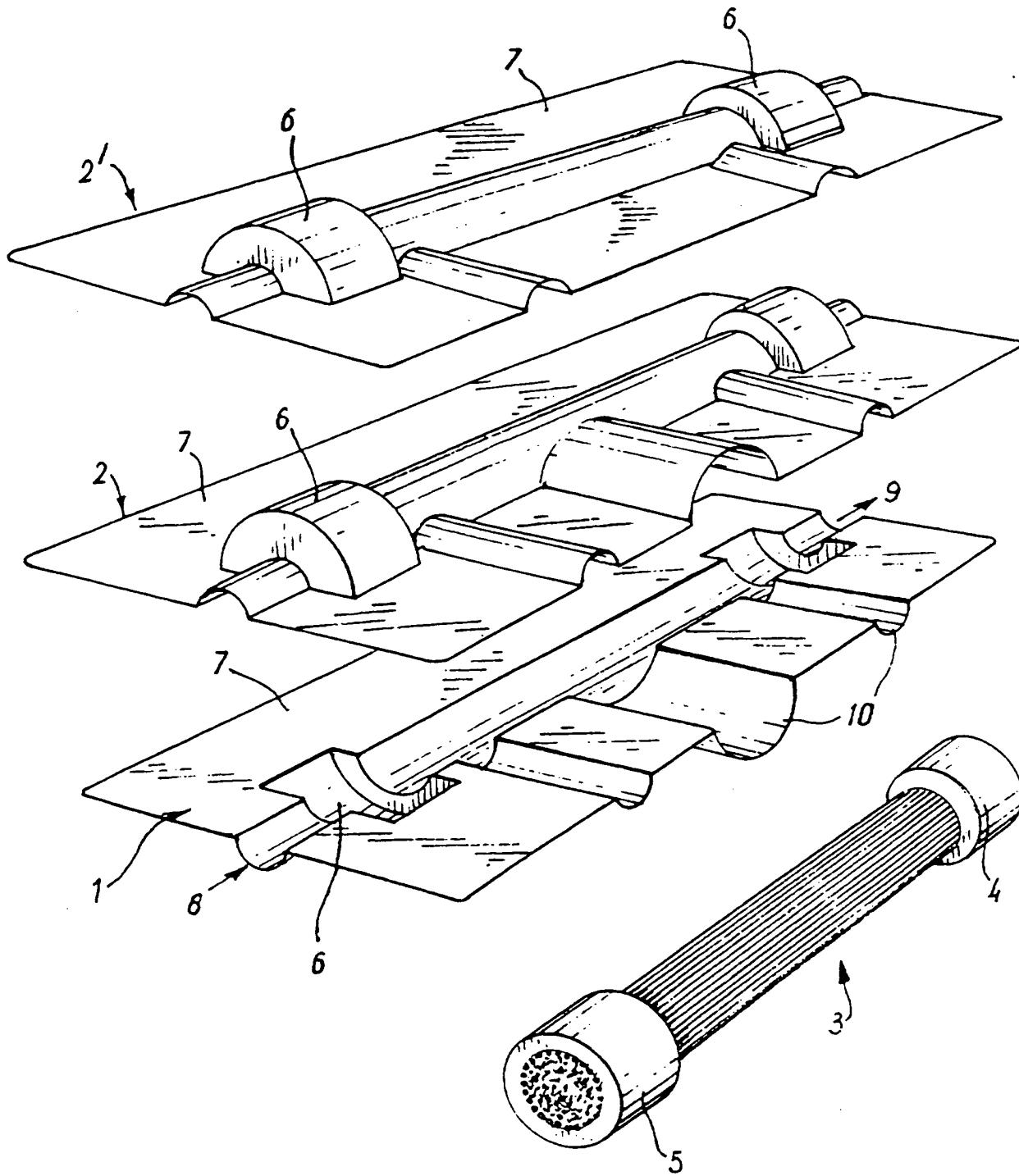


FIG 2

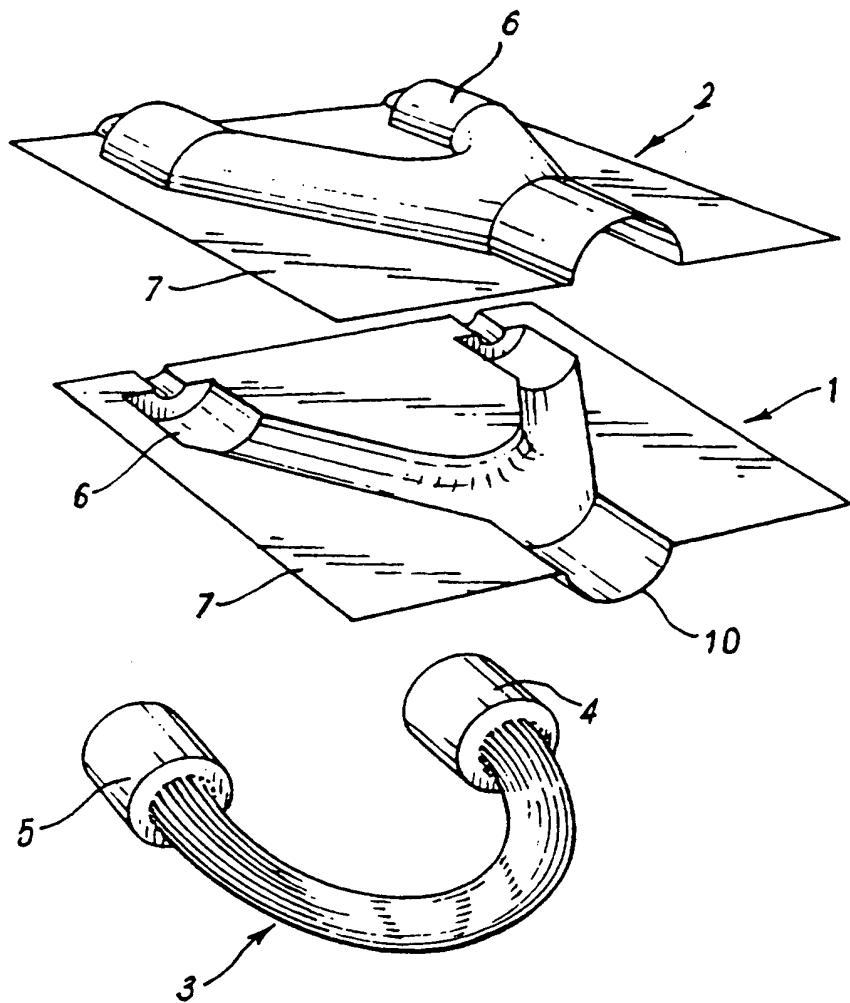


Fig. 3

INTERNATIONAL SEARCH REPORT

Inte. Application No
PCT/GB 95/01836

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B01D65/00 B01D63/02 B01D63/08 B01D29/01

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B01D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US,A,4 231 871 (B. J. LIPPS ET AL.) 4 November 1980 SEE ESPECIALLY COLUMN 12, LINES 9-29 ---	1
A	AU,A,4 801 972 (THE DOW CHEMICAL CO.) 26 April 1974 SEE ESPECIALLY FRON PAGE 12, LINE 25, TO PAGE 13, LINE 11 ---	1
A	EP,A,0 563 581 (MILLIPORE CORP.) 6 October 1993 see the whole document ---	1
A	US,A,5 011 555 (T. B. SAGER) 30 April 1991 see the whole document ---	1
A	EP,A,0 203 278 (AKZO GMBH) 3 December 1986 SEE ESPECIALLY FIGURES 3 AND 4 -----	

Further documents are listed in the continuation of box C.

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Date of the actual completion of the international search

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